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Mapping the Landscape of Chemo-Entrepreneurship in Indonesia: A Content Analysis and Research Trend Review

Muhammad Habib Ash Shiddiqi[1], Rabiatul Adawiyah[2], Dyah Purwaningsih[1]
[1]Chemistry Education Department, Faculty of Mathematic and Science, Yogyakarta State University,
Jl. Colombo Yogyakarta No.1, Karang Malang, Caturtunggal, Kec. Depok, Kabupaten Sleman, Daerah Istimewa Yogyakarta 55281.
[2]Chemistry Education, Faculty of Tarbiyah and Teacher Training, Sunan Doe Institute of Islamic Studies,
Jl. Soekarno Hatta, Rumbuk, Kec. Sakra, Kabupaten Lombok Timur, Nusa Tenggara Barat. 83671

Corresponding author
editor@sunankalijaga.org

Abstract: Chemo-Entrepreneurship (CEP) is an innovative approach in chemistry education that integrates mastery of scientific concepts with entrepreneurial skills to foster students' critical, creative, and productive thinking abilities. This study aims to map the development and research trends related to CEP in Indonesia and to analyze the direction of chemistry learning model development that combines conceptual, practical, and economic value aspects in the teaching–learning process. The method employed is a Systematic Literature Review (SLR) combined with descriptive content and bibliometric analyses of 287 articles published during 2016–2023, analyzed following PRISMA guidelines and visualized using VOSviewer. The analysis results indicate a significant increase in publications since 2016, with a primary focus on learning outcomes, creative thinking skills, life skills, and entrepreneurial interest. The dominant research designs are experimental and Research and Development (R&D), oriented toward the development of modules, e-worksheets, and digital-based learning media applied to various chemistry topics such as colloidal systems, buffer solutions, acids and bases, and hydrocarbons. The review shows that CEP implementation can enhance students' conceptual understanding, higher-order thinking skills, scientific creativity, and the ability to transform chemistry concepts into product innovations with economic value and social benefits. Moreover, CEP helps students understand the relationship between chemical theory and real-life production processes, thereby improving learning motivation and positive attitudes toward science. Nevertheless, studies on non-cognitive aspects, such as collaboration, scientific attitudes, and entrepreneurial character, remain limited, as do research employing mixed-method or longitudinal approaches. Research publications are still concentrated in a few major universities and predominantly in national journals, indicating the need to expand collaboration, diversify methodologies, and intensify international publications to strengthen CEP's contribution to innovation in chemistry education in Indonesia.

Keywords: Chemo-Entrepreneurship; Chemistry; Systematic Literature Review.

Introduction

In this era of globalization and rapid technological development, chemistry educationfaces the challenge of not only teaching scientific concepts, but also preparing students for the real world and an increasingly competitive job market (Eilks & Hofstein, 2015a; Roehrig et al., 2007a). Therefore, chemistry education plays an important role in equipping students with a deep scientific understanding, as well as practical skills that can be applied in various industrial sectors and everyday life (Irwanto et al., 2017). However, traditional learning is often inadequate to meet the increasingly complex needs of the workplace (Burns, 2020; Harry, 2003). Therefore, innovative approaches such as Chemo-Entrepreneurship (CEP) have emerged as a solution, combining theoretical concepts with practical entrepreneurial skills (Ismulyati & Ikhwani, 2018; Wijayati & Rengga, 2009)

Chemo-Entrepreneurship (CEP) is a learning strategy that integrates chemistry knowledge with entrepreneurial skills, providing students with real-world experience in understanding the process of processing raw materials into products of

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economic value and fostering an entrepreneurial spirit (Asmorowati, 2009; Lestari & Premono, 2019) This approach aims to increase the relevance of chemistry learning to everyday life and the industrial world (Kusuma & Kurniati, 2009; S. S. Sumarti et al., 2018) In addition to focusing on understanding chemical concepts, CEP also develops students' abilities to identify business opportunities, innovate, and create chemistry-based products that have economic value (Anwar et al., 2012).

Based on previous research, the Chemo-Entrepreneurship approach has been proven to have a positive impact in various aspects of learning. Several studies show that the application of this approach can improve academic achievement, life skills, and foster interest and motivation for entrepreneurship among students (Ismulyati & Ikhwani, 2018; Wijayati & Rengga, 2009). Recent research results also indicate that the integration of Chemo-Entrepreneurship with interactive technology, such as the use of Android-based applications, has received positive responses from students and educators. This innovation not only enriches the learning experience but also strengthens the relevance between chemistry concepts and the world of work and entrepreneurship (Kurnia et al., 2022).

The integration of CEP with various learning models, for example in the topic of colloidal systems, shows positive results and makes it easier for students to understand the conversion of raw materials into products (Ismulyati & Ikhwani, 2018; Ni'mah & Suwardi, 2023) In addition, the CEP module has been proven to be effective and valid for high school and university students (Arfin, Latisma, & Oktavia, 2018; Pinta et al., 2018), as well as enhancing students' creativity and innovation, as evidenced by the improvement in their life skills (Kusuma & Siadi, 2010).

The importance of integrating entrepreneurial values into chemistry education is also in line with the concept of academic entrepreneurship, which emphasizes the role of universities as centers for developing innovations that have commercialization potential and social impact (Guindalini et al., 2021a). Through this approach, universities function not only as institutions of education and research, but also as incubators of ideas and solutions that can be applied in the industrial world. In this regard, the Chemo-Entrepreneurship Program (CEP) plays an important role as a bridge between the chemistry theory taught in the classroom and its practical application in real life. This approach helps students understand the relevance of chemistry to the needs of industry and the world of work, while fostering innovative skills and an entrepreneurial orientation (Brown et al., 2010; Nwakaego & Kabiru, 2015a).

Although the Chemo-Entrepreneurship Program (CEP) shows great potential in developing students' scientific skills and entrepreneurial spirit, research on its implementation, learning approaches, and impact on learning outcomes is still scattered and not yet integrated. Therefore, a systematic literature review is needed to combine various previous research findings, identify the direction and trends of studies that have been conducted, and provide a comprehensive understanding of the effectiveness of CEP in chemistry education, especially in improving students' conceptual understanding and entrepreneurial character.

Materials And Methods

This study uses the Systematic Literature Review (SLR) method combined with descriptive content analysis to examine the development of chemo-entrepreneurship research in Indonesia. The SLR method is an observational approach that follows standard guidelines for identifying and synthesizing relevant research articles (Xiao & Watson, 2019). Data were collected from articles related to the topic of chemo-entrepreneurship through the Google Scholar and Scopus databases, published between 2016 and 2023. The article search process was conducted using the keywords "chemo-entrepreneurship," "CEP," and "chemistry entrepreneurship." From the selection results, 176 relevant articles were analyzed using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) method to ensure a rigorous

selection process and relevance to the research topic.

In the classification process, the instrument used was adapted from the Paper Classification Form (PCF) by Kizilaslan et al., (2012). This instrument covers various categories such as scientific discipline, research methods, research design, and data analysis methods. This approach allows researchers to identify various important aspects of each article, such as the focus of the study, the type of data used, and the methodological approach applied.

To improve accuracy and efficiency in the analysis, this study was also supported by a bibliometric approach developed by Van Eck & Waltman, (2014). This approach enables automation in keyword grouping and analysis, which speeds up the process of identifying research patterns and trends. Bibliometric analysis was performed using VOSviewer software (N. Van Eck & Waltman, 2010). to visualize bibliometric networks and identify thematic clusters from the analyzed articles.

By combining a structured Systematic Literature Review method (Xiao & Watson, 2019), descriptive content analysis, and a VOSviewer-based bibliometric approach, this study aims to provide a comprehensive overview of the chemo-entrepreneurship research landscape in Indonesia, including the identification of patterns, gaps, and opportunities for further research.

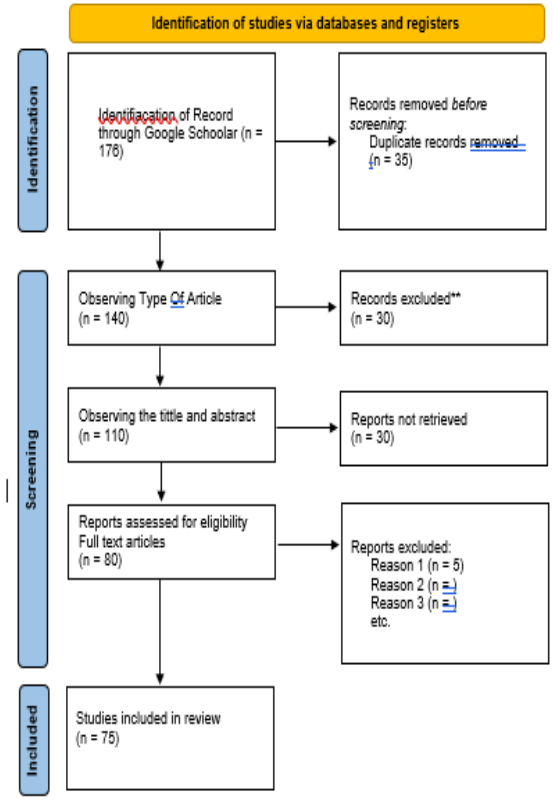

Figure 1. Article Selection Results

Results And Discussion

Result

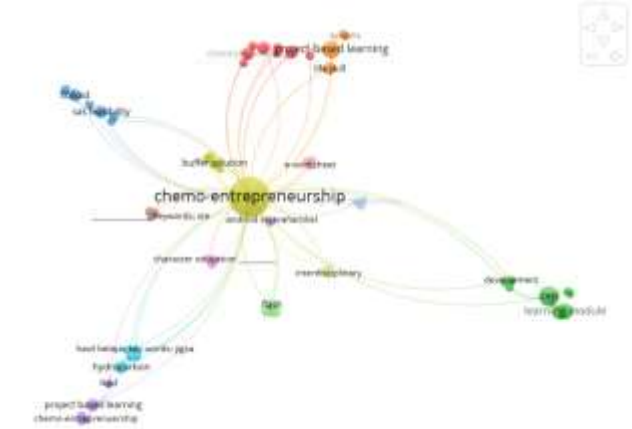

Figure 2. CheChemo-Entrepreneurship VosViewer visualization results

Chemo-Entrepreneurship (CEP) is an innovative approach to chemistry education that combines an understanding of chemistry concepts with the development of entrepreneurial skills. Based on the results of network visualization

generated by VOSviewer, CEP plays a central role and is connected to various other important terms, such as project-based learning, life skills, and the application of technology in education, such as e-worksheets and Android-based platforms. These terms show how project-based learning and technology integration can create more interactive learning. This not only helps students understand scientific concepts, such as buffer solutions and hydrocarbons, but also develops entrepreneurial skills and character education through a cross-disciplinary approach. In addition, the development of learning modules that support CEP is one of the main concerns in efforts to improve the effectiveness of this model in the classroom environment.

However, from the results of this network analysis, there are several research gaps that could be the focus of further research. First, despite the connection with technologies such as e-worksheets and Android platforms, there is still a lack of research evaluating the extent to which the use of these digital tools can improve students' critical thinking, creativity, and collaboration skills. Second, although character education is an integral part of CEP, studies examining how character education related to entrepreneurship is incorporated into chemistry learning are still limited. Third, the interdisciplinary approach in CEP has not been fully explored, especially in combining other sciences, such as economics and social sciences, into the curriculum to improve learning outcomes. Fourth, the effectiveness of learning modules designed for CEP is rarely evaluated, so further studies are needed on their impact on students' academic achievement and entrepreneurial skills. Fifth, there is still a lack of research examining the relationship between CEP and the development of 21st-century skills, such as critical thinking, communication, collaboration, and creativity. Finally, the long-term impact of CEP implementation on entrepreneurship outside the school environment has not been widely discussed, so it is important to explore how CEP can contribute to students' career development in the real world.

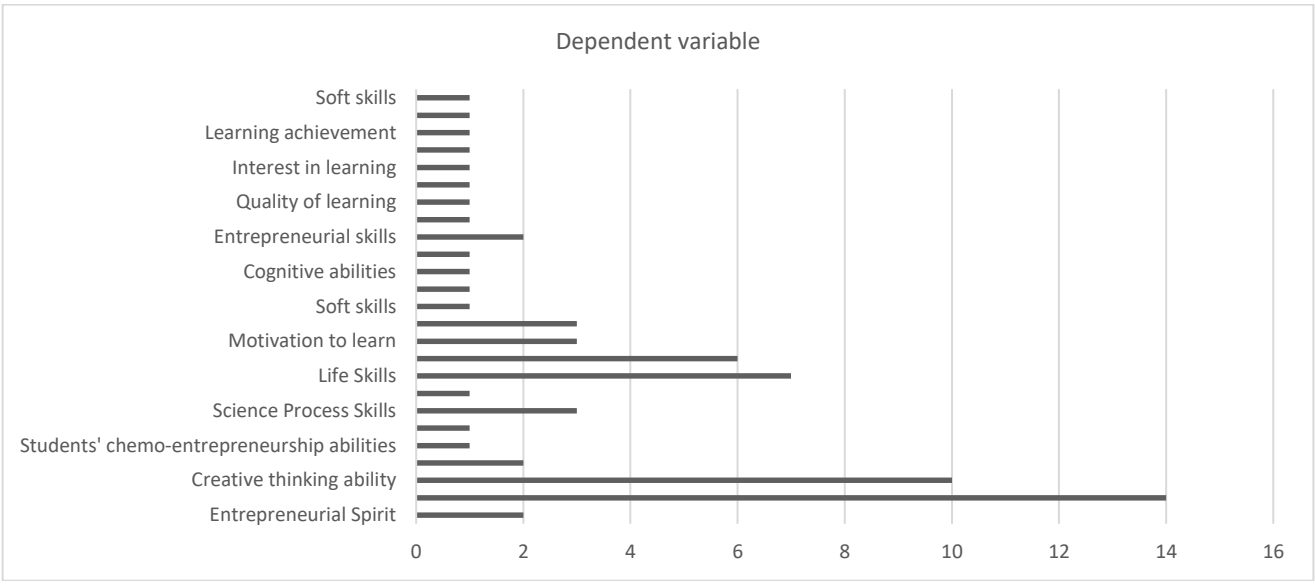

Figure 3. Dependent variables used in the Chemo-Entrepreneurship study

Based on the results of the literature review, the most dominant dependent variable studied in Chemo-Entrepreneurship research is learning outcomes, which appeared 14 times in the measurements. This shows that most studies still focus on cognitive aspects as the main indicator of the effectiveness of the learning approach. Furthermore, creative thinking skills emerged as a frequently studied variable (10 times), followed by life skills (7 times) and entrepreneurial interest (6 times), reflecting efforts to link chemistry learning with the development of 21st-century skills and an

entrepreneurial orientation. Meanwhile, variables such as learning motivation, conceptual understanding, and scientific process skills appear in more limited numbers, indicating the potential for research development in the affective and scientific thinking process dimensions. On the other hand, studies on non-cognitive aspects such as collaboration skills, scientific attitudes, and soft skills are still relatively rare, even though these dimensions play an important role in supporting the formation of entrepreneurial character and student readiness to face the challenges of a science-based world of work.

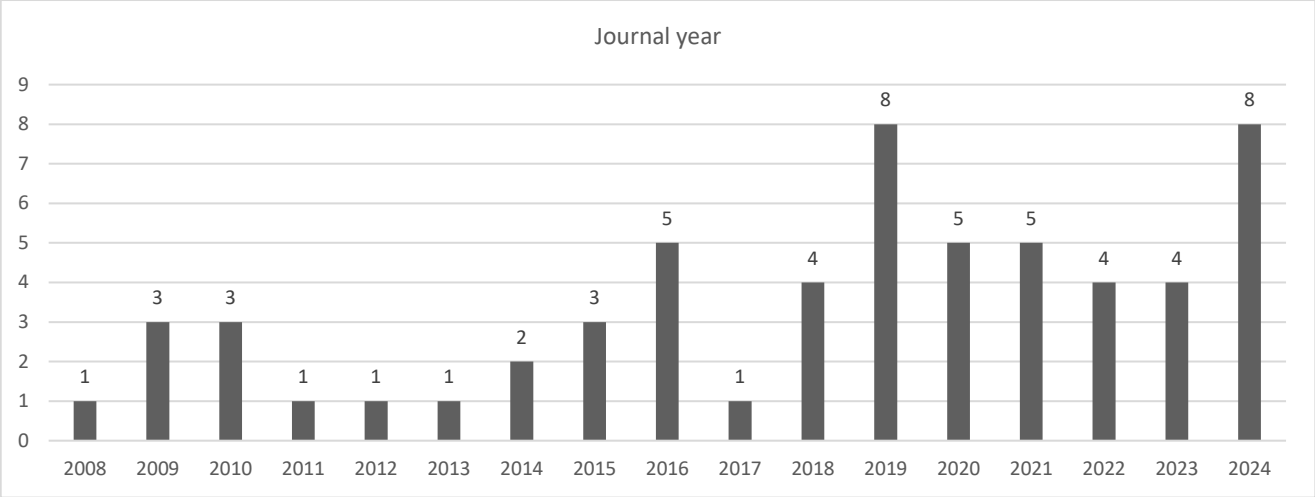

Figure 3. Journal year.

Research publications related to the Chemo-Entrepreneurship Program (CEP) have shown a significant increase since 2016, with peak research productivity occurring in 2019 and increasing again in 2023. This trend indicates that the issue of integrating entrepreneurship into chemistry education is gaining attention among academics and education practitioners. This increase also reflects a paradigm shift in chemistry education research from a traditional focus on conceptual aspects to a more applied, innovative, and relevant approach to the needs of the workplace. Thus, this consistent growth in publications confirms that CEP is beginning to be recognized as a strategic direction for research in supporting entrepreneurship-based science education at the national level.

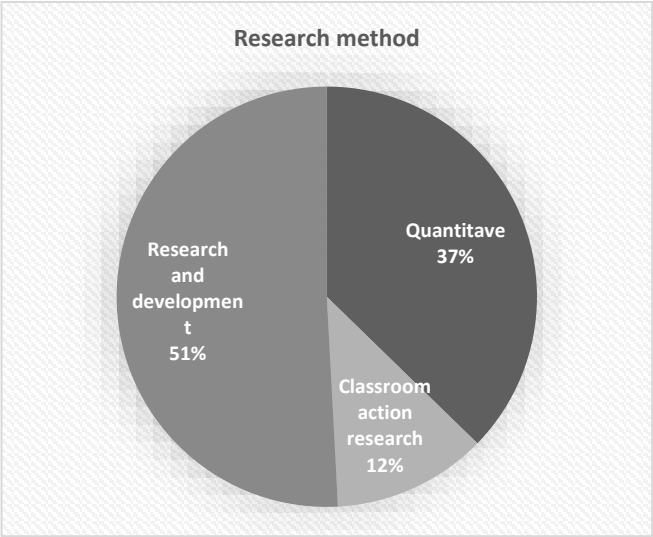

Figure 4. Research method

The most widely used research method in Chemo-Entrepreneurship Program (CEP) studies is Research and Development (R&D), with a total of 30 publications adopting this approach. The dominance of the R&D method indicates that most studies are oriented towards the development and validation of learning products, whether in the

form of modules, interactive media, or teaching tools based on chemical entrepreneurship. Furthermore, quantitative research ranks second with 22 articles, indicating researchers' interest in empirically measuring the effectiveness of CEP implementation through hypothesis testing and statistical analysis. Meanwhile, classroom action research (CAR) is recorded in 7 publications, which generally focus on the direct application of CEP in the classroom to improve student learning outcomes and skills. The use of mixed methods and qualitative approaches is still relatively limited, opening opportunities for further research to explore contextual aspects, learning processes, and student experiences in a more in-depth and holistic manner.

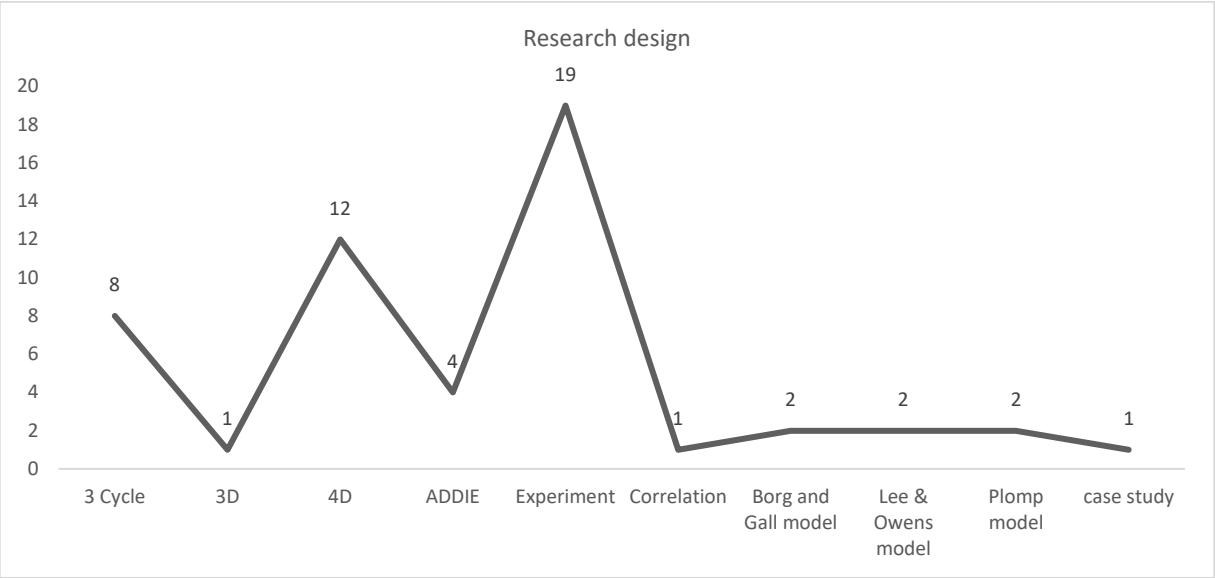

Figure 5. Research Design

The most dominant research designs used in Chemo-Entrepreneurship (CEP) studies are experimental designs in 19 articles and 4D development models in 12 articles. Both designs confirm the tendency of researchers to focus their studies on the development of learning innovations and testing the effectiveness of the resulting educational products or interventions. In addition, several studies also adopted the three-cycle model and ADDIE development design, although the number was relatively small. Research designs such as Borg & Gall and case studies are still rarely used, indicating that an in-depth exploration-based approach to the context of CEP implementation has not been widely developed. The dominance of experimental and development-based research shows that the main focus of CEP studies is on testing instructional innovations and validating learning products, particularly those that integrate entrepreneurial concepts in the context of chemistry to increase the relevance, effectiveness, and engagement of students in the learning process.

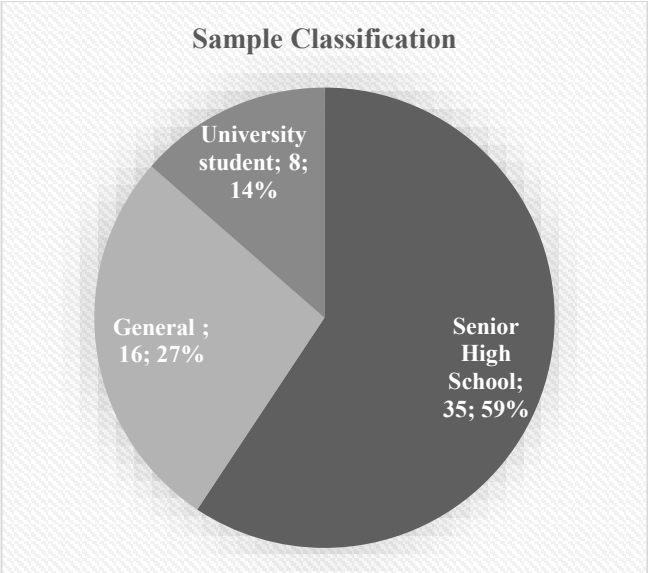

Figure 6. Sample classification

The most commonly used research subjects in Chemo-Entrepreneurship Program (CEP) studies

are high school students, with a total of 33 articles. This shows that high school is the main target in the implementation of the CEP approach, because at this stage, students are considered to have sufficient abstract thinking skills to integrate chemistry concepts with entrepreneurial principles. Furthermore, the general category (without specification of education level) was recorded in 16 articles, while university students were the subjects in 8 studies that generally focused on the development of prospective chemistry teachers or the implementation of CEP in the context of higher education. Meanwhile, Madrasah Aliyah (MA) was only recorded in 2 publications, which indicates that the application of CEP in religious-based educational institutions is still limited. This pattern illustrates that CEP research is still concentrated at the general secondary education level, while exploration at other levels such as primary, vocational, and higher education remains an open opportunity for future research development.

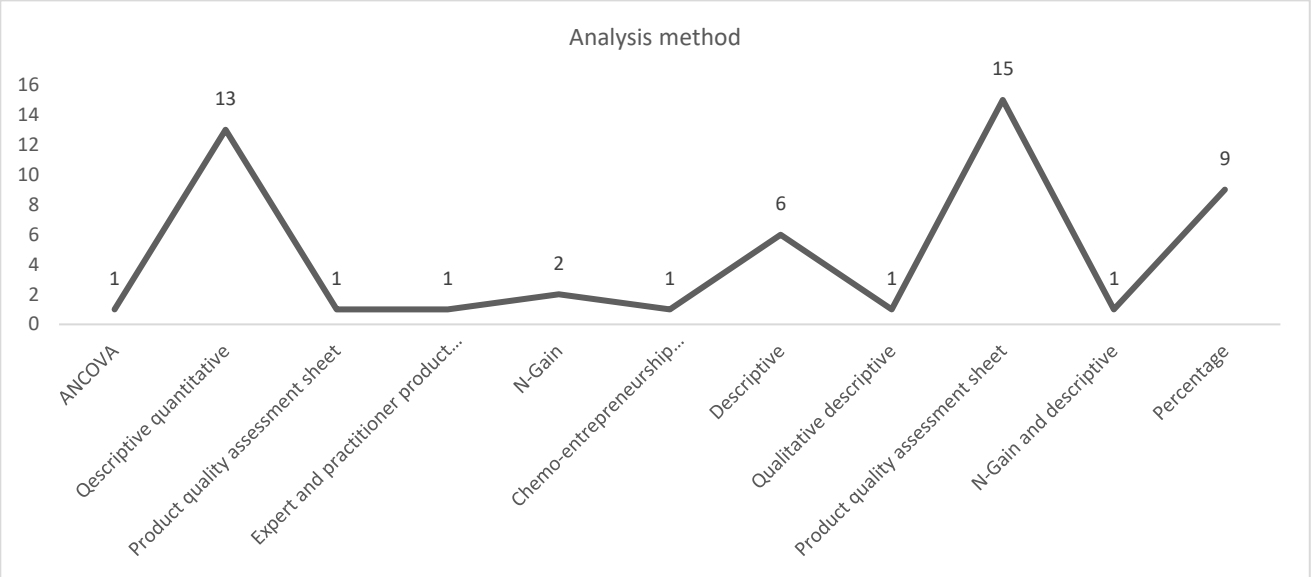

Figure 7. Analysis method

The majority of research in the Chemo-Entrepreneurship Program (CEP) study uses quantitative descriptive analysis as the main approach in data processing. This approach is widely used to describe the results of learning product trials, student responses, and the overall effectiveness of program implementation. In addition, validity and reliability tests are also frequently applied, particularly in research focused on the development of teaching tools, to ensure the suitability of instruments and the consistency of measurement results. However, advanced analytical methods such as inferential statistics, mixed-method approaches, and in-depth qualitative analysis are still rarely used. This limitation indicates that most CEP research still focuses on the initial development stage and description of results, while a more comprehensive exploration of contextual factors, learning processes, and the long-term impact of CEP implementation still requires more attention in further research.

Discussion

The results of the analysis of Chemo-Entrepreneurship (CEP) research trends show that this approach is gaining attention in chemistry education in Indonesia, especially since 2016, peaking in 2019 and 2023. This increase in publications indicates that CEP is seen as an important innovation in responding to the challenges of 21st-century learning. The most frequently studied variables are learning outcomes, creative thinking skills, life skills, and entrepreneurial interest. This shows that research is more oriented towards academic achievement and

cognitive skills. National studies support these findings, such as the research by Ismulyati et al., (2018) and S. Sumarti et al., (2016), which show that CEP can improve student learning outcomes and entrepreneurial interest. However, non-cognitive variables such as communication, attitude, collaboration, and soft skills are still rarely studied. In fact, international research shows that these aspects play a major role in linking science education to work readiness. Brown et al. (2010) emphasize that the integration of entrepreneurship in chemistry strengthens students' collaborative and problem-solving abilities, while Guindalini et al., (2021) highlight the importance of an academic entrepreneurial ecosystem that encourages cross-disciplinary innovation.

From a methodological perspective, the majority of studies use quantitative descriptive analysis, focusing on the validity and reliability of teaching tools (Arfin, Latisma et al., 2018; Lestari et al., 2019), Research using longitudinal, mixed-method, and in-depth qualitative approaches is still very limited. This is a research gap, as the long-term effectiveness of CEP on entrepreneurial skills and work readiness has not been empirically proven. In contrast, international studies use more diverse methodologies. Roehrig et al., (2007) examined curriculum implementation using a longitudinal approach, while Burns (2020) emphasized the importance of qualitative research in understanding lifelong learning. The most productive institutions in CEP research are Malang State University, followed by Surabaya State University, Padang State University, and UIN Sunan Kalijaga. This research concentration shows the existence of research clusters at certain universities, but CEP research is still not evenly distributed nationwide. This indicates the need for cross-institutional collaboration so that CEP implementation can be expanded to various regions. In terms of publications, most CEP research is published in national journals such as the Journal of Science Education and the Indonesian Journal of Science Education (S. Sumarti et al., 2016). Contributions to international journals are still minimal, so global recognition of the CEP model is still limited. Publication in international journals will strengthen Indonesia's position in the global science education discourse (Nwakaego & Kabiru, 2015).

Most research on the *Chemo-Entrepreneurship Program* (CEP) employs experimental designs and 4D model development to produce innovative learning tools such as modules, e-worksheets, and digital teaching materials integrated with entrepreneurship-oriented chemistry learning (Fitriyani & Suprihatiningrum, 2024; Pinta et al., 2010). This pattern indicates a strong orientation toward instructional innovation and product validation, emphasizing the practical development of learning resources rather than theoretical exploration. However, case studies, policy evaluations, and cost–benefit analyses remain relatively uncommon, suggesting that the broader systemic and economic implications of CEP have not yet been thoroughly explored. According to Ni'mah et al., (2023) future studies should incorporate longitudinal and evaluative approaches to assess the sustainability and long-term effectiveness of CEP implementation. This aligns with international perspectives; for instance, Liguori & Winkler, (2020) in *Entrepreneurship Education and Pedagogy* emphasize the importance of conducting long-term evaluations in entrepreneurship education to measure the lasting impact of curricular interventions on alumni career development and entrepreneurial engagement.

Research and Development (R&D) dominates, followed by quantitative research and classroom action research. This is relevant for the development of teaching tools, but limits methodological perspective variation. In comparison, research by Lackéus, (2018) shows that the use of action research in entrepreneurship education can be more effective in understanding the dynamics of project-based learning. Therefore, developing CEP research with action research, mixed methods, or long-term evaluation will enrich our understanding of its effectiveness. The majority of research subjects focus on high school students, followed by university students and the general category. This is logical because high school is an important phase in the formation of life skills and career orientation. However, international research such as Eilks & Hofstein, (2015) emphasizes that the integration of

entrepreneurship into the science curriculum should begin in elementary school so that 21st-century skills are instilled more strongly from an early age. Research at the university level is also still limited, even though the potential for applying CEP in higher education and vocational education is enormous, especially in supporting chemistry-based innovation and start-ups.

Chemo-Entrepreneurship (CEP) and Integrated Learning Models

The integration of Chemo-Entrepreneurship (CEP) with various innovative learning models is a new direction in modern chemistry education. CEP, as an approach that combines chemistry concepts with entrepreneurial values, is increasingly relevant when collaborated with active learning models such as Project-Based Learning (PjBL), Problem -Based Learning (PBL), Inquiry-Based Learning, Laboratory-Based Learning, and the use of digital technology in 21st-century learning. According to Sitompul et al., (2024), the integration of the PjBL model with the CEP approach has been proven to improve students' understanding of chemistry concepts and foster their interest in entrepreneurship. In this model, students not only learn scientific concepts but are also directly involved in projects to create simple chemical products that have market value. This approach strengthens critical, collaborative, and creative thinking skills as students are encouraged to design, create, and market the results of their chemistry experiments in real life.

Maulida & Kamaludin, (2024) emphasize the importance of integrating CEP with digital technology, for example through the development of e-modules based on digital flipbook makers that contain material on chemical bonds. Their research results show that the application of CEP-based digital media not only increases student motivation to learn but also expands access to interactive and engaging learning resources. Similar findings were reported by (Holivvarni et al., 2022), who developed a CEP-based chemistry e-module on ion equilibrium and salt solutions. The module was proven to be valid and suitable for use, while also motivating students to relate chemistry concepts to entrepreneurial ideas based on chemical products.

In addition to digital technology integration, Ramlah, et al., (2023) added that the development of CEP-based learning modules on colloid material can improve learning outcomes and foster entrepreneurial spirit among students. This is in line with the views of Aslam, et al (2024), who reviewed the effectiveness of Project-Based Learning in chemistry education. They concluded that the PjBL model creates connections between theory and practice that are in line with the CEP philosophy namely, learning that is relevant to the real world, results-oriented, and fosters the ability to produce products. Thus, integrating CEP with various project-based, problem-based, laboratory-based, and digital technology-based learning models is a strategic step toward creating chemistry learning that not only understands scientific concepts but also fosters an entrepreneurial spirit, critical thinking skills, and readiness to face science-based industrial challenges in the modern era.

The Role of Chemo-Entrepreneurship (CEP) Based on Variables

The results of the *Systematic Literature Review* (SLR) indicate that the role of the *Chemo-Entrepreneurship Program* (CEP) in chemistry education can be identified through several key variables, including chemical entrepreneurship skills, learning motivation, experimental innovation, and learning outcomes. These variables serve as essential indicators for evaluating the effectiveness of CEP implementation across different levels of formal education, both at the secondary and tertiary levels.

Ramlah et al. (2023) found that the use of CEP-based *e-modules* in colloid topics not only significantly improved students' learning outcomes but also fostered their entrepreneurial interest in chemistry-based products. Similarly, Maulida and Kamaludin (2024) reported that integrating CEP into digital flipbook *e-modules* enhanced students' learning motivation and created a more contextual and meaningful learning experience. Holiwarni et al. (2022) highlighted the contribution of CEP in developing students' creative thinking and experimental skills through project-based learning activities. In line with these

findings, Sitompul et al. (2023) emphasized that the application of the *Project-Based Learning* (PjBL) model combined with CEP strengthens students' analytical and problem-solving abilities in addressing real-life situations.

From an international research perspective, Aslam et al. (2024) assert that the *Project-Based Learning* approach effectively bridges the gap between theory and practice in chemistry education, particularly when combined with entrepreneurship-oriented frameworks such as the *Chemo-Entrepreneurship Program* (CEP). This integration has been shown to enhance students' higher-order thinking skills, creativity, and innovative orientation.

The findings suggest that CEP plays a strategic role in developing several key variables within chemistry learning: (1) improving students' learning outcomes, (2) strengthening learning motivation, (3) fostering entrepreneurial interest and skills, and (4) encouraging innovation in experimental and laboratory activities. However, further research employing longitudinal and mixed-method designs is recommended to measure the long-term impact of CEP on students' entrepreneurial competence development and career readiness in the future.

The Future Prospects of Chemo-Entrepreneurship (CEP) in Chemistry Education

The future prospects of Chemo-Entrepreneurship (CEP) in chemistry education are very promising because this approach is in line with the 21st-century education paradigm that emphasizes the development of collaborative, innovative, creative, and solution-oriented skills to address global issues. Several promising directions for CEP development include improving student skills, integrating digital technology, developing a chemistry entrepreneurship curriculum, and opportunities for further research.

First, CEP has the potential to improve students' 21st-century skills, particularly in critical thinking, collaboration, creativity, and communication (4C). Through CEP-based project activities, students not only understand chemistry theory but also learn to design products, manage production processes, and understand the economic value of experimental results. Ramlah et al. (2023) emphasize that the CEP approach fosters an entrepreneurial spirit and ecological awareness through the use of environmentally friendly chemicals, providing students with a holistic and applicable learning experience.

Second, from a technological perspective, CEP can be further developed through the use of digital media such as e-learning, mobile applications, and virtual laboratories. Maulida and Kamaludin (2024) show that flipbook-based e-modules provide a more engaging, interactive, and efficient learning experience. The integration of digital technology also enables the implementation of CEP in distance learning and hybrid learning.

Third, from a curriculum development perspective, CEP has the opportunity to be integrated into the national curriculum as part of applied science and STEM (Science, Technology, Engineering, and Mathematics)-based entrepreneurship education. Sitompul et al., (2024) emphasize that CEP can be used as an interdisciplinary learning model that combines chemistry, economics, and character education to produce graduates who are competitive in the world of industry and research. Fourth, opportunities for further research are wide open. Holivvarni et al., (2022) suggest further studies on the effectiveness of digital-based CEP on students' critical thinking and product innovation skills. In addition, Aslam et al. (2024) recommend longitudinal research to assess the extent to which the implementation of CEP affects the sustainability of students' interest in entrepreneurship in the real world.

Thus, the future prospects of CEP in chemistry education are not only focused on improving academic outcomes, but also on developing entrepreneurial character, innovation, and readiness to face science-based industrial transformation in the digital age. The integration of CEP with technology, interdisciplinary curricula, and applied research will make chemistry education more relevant, adaptive, and globally competitive.

Conclusions

Chemo-Entrepreneurship (CEP) has proven to be an innovative approach capable of bridging chemistry learning with 21st-century entrepreneurial skills. A systematic review shows that CEP not only improves students' learning outcomes, creativity, and life skills but also fosters entrepreneurial interest through the integration of project-based learning, module development, and the use of digital technology. However, research remains dominated by R&D methods and small-scale experiments, with a limited focus on specific topics, specific institutions, and national publications. Emerging research gaps include the lack of longitudinal studies, interdisciplinary integration, comprehensive evaluation of digital technology, and analysis of the long-term impact on students' entrepreneurial careers. Therefore, CEP has great potential for broader development as a relevant, adaptive, and globally competitive learning model. To optimize its impact, further research is needed that prioritizes methodological diversification, cross-disciplinary collaboration, and synergy between education, industry, and the entrepreneurial ecosystem.

Conflict of Interest: there are no conflicts of interest concerning the publication of this article.

References

Anwar, M., Supardi, & Sugiharto, D. (2012). Pengembangan Perangkat Pembelajaran Biologi Dengan Pendekatan Bioenterpreneurship Untuk Meningkatkan Keterampilan Proses Ilmiah Dan Minat Berwirausaha Siswa. *Innovative Journal of Curriculum and Educational Technology*. https://www.semanticscholar.org/paper/PENGEMBANGAN-PERANGKAT-PEMBELAJARAN-BIOLOGI-DENGAN-Anwar-Supardi/1f30e800c92f3c6293abdb2c7f63793521948e39

Arfin, W., Latisma, L., & Oktavia, B. (2018). A development module of chemistry learning based on chemo-entrepreneurship oriented. *Proceedings of the International Conferences on Educational, Social Sciences and Technology - ICESST 2018*, 394–400. https://doi.org/10.29210/2018157

Arfin, W., Latisma, L., on Educational, B. O.-I. C., & undefined 2018. (2018). A development module of chemistry learning based on chemo-entrepreneurship oriented. *Gci.or.Id*. https://doi.org/10.29210/2018157

Asmorowati, D. S. (2009). *PEMBELAJARAN KIMIA MENGGUNAKAN KOLABORASI KONSTRUKTIF DAN INKUIRI BERORIENTASI CHEMO-ENTREPRENEURSHIP*.

Brown, M. E., Cosser, R. C., Davies-Coleman, M. T., Kaye, P. T., Klein, R., Lamprecht, E., Lobb, K., Nyokong, T., Sewry, J. D., Tshentu, Z. R., Van Der Zeyde, T., & Watkins, G. M. (2010). Introducing Chemistry Students to the "Real World" of Chemistry. *Journal of Chemical Education*, *87*(5), 500–503. https://doi.org/10.1021/ed8001539

Burns, R. (2020). *Adult Learner at Work: The challenges of lifelong education in the new millenium*. Routledge.

Eilks, I., & Hofstein, A. (2015a). *Relevant chemistry education: From theory to practice*. https://www.semanticscholar.org/paper/Relevant-chemistry-education-%3A-from-theory-to-Eilks-Hofstein/6125adfcd0c1bb83764bf4cba794a67993423df2

Eilks, I., & Hofstein, A. (2015b). *Relevant chemistry education: From theory to practice*. Brill. https://brill.com/downloadpdf/display/title/37466.pdf

Fitriyani, R., & Suprihatiningrum, J. (2024). Development of TikTok-based Chemo-entrepreneurship e-Worksheet to Fostering Studentsâ€™ Entrepreneurial Spirit. *Jurnal Paedagogy*, *11*(1), 37–47.

Guindalini, C., Verreynne, M.-L., & Kastelle, T. (2021a). Taking scientific inventions to market: Mapping the academic entrepreneurship ecosystem. *Technological Forecasting and Social Change*, *173*, 121144. https://doi.org/10.1016/j.techfore.2021.121144

Guindalini, C., Verreynne, M.-L., & Kastelle, T. (2021b). Taking scientific inventions to market: Mapping the academic entrepreneurship ecosystem. *Technological Forecasting and Social Change*, *173*, 121144.

Harry, K. (2003). Distance Education in Transition: New trends and challenges. *The International Review of Research in Open and Distributed Learning*, *4*(2). https://doi.org/10.19173/irrodl.v4i2.145

Holivvarni, B., Erna, M., & Sari, M. (2022). *Validity of E-module on Ion equilibrium and pH of salt solution oriented Chemo-Entrepreneurship (CEP)*. https://www.researchgate.net/profile/Maria-Erna/publication/361597220_Validity_of_E-module_on_Ion_equilibrium_and_pH_of_salt_solution_oriented_Chemo-Entrepreneurship_CEP/links/62ea1e8d9d410c5ff37fb50b/Validity-of-E-module-on-Ion-equilibrium-and-pH-of-salt-solution-oriented-Chemo-Entrepreneurship-CEP.pdf

Irwanto, Rohaeti, E., Widjajanti, E., & Suyanta. (2017). *Students' science process skill and analytical thinking ability*

in chemistry learning. 030001. https://doi.org/10.1063/1.4995100

Ismulyati, S., & Ikhwani, Y. (2018). Pengaruh Pendekatan Chemo-Entrepreneurship (CEP) terhadap Minat dan Hasil Belajar Siswa SMA N 1 Bukit Kabupaten Bener Meriah Pada Materi Perubahan Materi. *Lantanida Journal*, *6*(1), 28–38.

Ismulyati, S., Journal, Y. I.-L., & undefined 2018. (2018). Pengaruh Pendekatan Chemo-Entrepreneurship (CEP) terhadap Minat dan Hasil Belajar Siswa SMA N 1 Bukit Kabupaten Bener Meriah Pada Materi Perubahan. *Jurnal.Ar-Raniry.Ac.Id*, *6*(1), 1–102.

Kizilaslan, A., Sozbilir, M., & Yasar, M. D. (2012). Inquiry Based Teaching in Turkey: A Content Analysis of Research Reports. *International Journal of Environmental and Science Education*, *7*(4), 599–617.

Kurnia, M. R. A., Haryanto, H., Sanova, A., & Dewi, C. A. (2022). Studi Respon Siswa Terhadap Pengembangan Multimedia Interaktif Berbasis Chemo-Entrepreneurship Berbentuk Aplikasi Android. *Hydrogen: Jurnal Kependidikan Kimia*, *10*(1), 10. https://doi.org/10.33394/hjkk.v10i1.4954

Kusuma, E., & Kurniati, I. (2009). *PENGGUNAAN PENDEKATAN CHEMO-ENTREPRENEURSHIP BERORIENTASI GREEN CHEMISTRY UNTUK MENINGKATKAN KEMAMPUAN LIFE SKILL SISWA SMA*.

Kusuma, E., & Siadi, K. (2010). *PENGEMBANGAN BAHAN AJAR KIMIA BERORIENTASI CHEMO-ENTREPRENEURSHIP UNTUK MENINGKATKAN HASIL BELAJAR DAN LIFE SKILL MAHASIWA*. https://www.semanticscholar.org/paper/PENGEMBANGAN-BAHAN-AJAR-KIMIA-BERORIENTASI-UNTUK-Kusuma-Siadi/dae5c1ae73b8b32e383dc81ad74aab802fdbcb56

Lackéus, M. (2018). "What is Value?" – A Framework for Analyzingand Facilitating Entrepreneurial Value Creation. *Uniped*, *41*(1), 10–28. https://doi.org/10.18261/issn.1893-8981-2018-01-02

Lestari, A., And, S. P.-J. of T. C. R., & undefined 2019. (2019). Pengembangan Modul Kimia Berbasis Inkuiri Terbimbing Berorientasi Chemo-Entrepreneurship Materi Sifat Koligatif Larutan. *Academia.Edu*. https://www.academia.edu/download/73942146/15.pdf

Lestari, A., & Premono, S. (2019). Pengembangan Modul Kimia Berbasis Inkuiri Terbimbing Berorientasi Chemo-Entrepreneurship Materi Sifat Koligatif Larutan. *Journal of Tropical Chemistry Research and Education*, *1*(1), 29–35. https://doi.org/10.37079/jtcre.v1i1.20

Liguori, E., & Winkler, C. (2020). From Offline to Online: Challenges and Opportunities for Entrepreneurship Education Following the COVID-19 Pandemic. *Entrepreneurship Education and Pedagogy*, *3*(4), 346–351. https://doi.org/10.1177/2515127420916738

Maulida, M. Z., & Kamaludin, A. (2024). Development of e-module based on digital flipbook maker containing chemo-entrepreneurship (CEP) chemical bond material to increase high school student's interest in learning. *Jurnal Iqra': Kajian Ilmu Pendidikan*, *9*(2), 259–279.

Ni'mah, A., IPA, A. K.-J. P. P., & undefined 2023. (2023). Development of a Chemo-Entrepreneurship Practicum Video to Improve Material Understanding of Colligative Properties for Senior High School. *Jppipa.Unram.Ac.Id*, *9*(SpecialIssue), 24–36. https://doi.org/10.29303/jppipa.v9iSpecialIssue.5368

Ni'mah, A., & Suwardi, S. (2023). Implementation of the Chemo-Entrepreneurship Approach in Chemistry Learning: Systematic Review 2016â€"2023. *Jurnal Penelitian Pendidikan IPA*, *9*(SpecialIssue), Article SpecialIssue. https://doi.org/10.29303/jppipa.v9iSpecialIssue.5368

Nwakaego, O. N., & Kabiru, A. M. (2015a). The Need to Incorporate Entrepreneurship Education into Chemistry Curriculum for Colleges of Education in Nigeria. *Journal of Educational Policy and Entrepreneurial Research*. https://www.semanticscholar.org/paper/The-Need-to-Incorporate-Entrepreneurship-Education-Nwakaego-Kabiru/019986542d9cb0e5270151c2f505edd1c6187c53

Nwakaego, O. N., & Kabiru, A. M. (2015b). The need to incorporate entrepreneurship education into chemistry curriculum for colleges of education in Nigeria. *Journal of Educational Policy and Entrepreneurial Research*, *2*(5), 84–90.

Pinta, Y., And, A. P.-I. J. of P. S., & undefined 2018. (2010). The Development of Chemo-entrepreneurship Oriented Practicum Guided for 10th Grade in Senior High School. *Academia.Edu*. https://www.academia.edu/download/77068487/235.pdf

Pinta, Y., Dj, L., & Putra, A. (2018, June 4). *The Development of Chemo-entrepreneurship Oriented Practicum Guided for 10th Grade in Senior High School*. https://www.semanticscholar.org/paper/The-Development-of-Chemo-entrepreneurship-Oriented-Pinta-Dj/0609e73b773a0f3504798838f2f0a5460824c666

Roehrig, G. H., Kruse, R. A., & Kern, A. (2007a). Teacher and school characteristics and their influence on curriculum implementation. *Journal of Research in Science Teaching*, *44*(7), 883–907. https://doi.org/10.1002/tea.20180

Roehrig, G. H., Kruse, R. A., & Kern, A. (2007b). Teacher and school characteristics and their influence on curriculum implementation. *Journal of Research in Science Teaching*, *44*(7), 883–907. https://doi.org/10.1002/tea.20180

Sitompul, H., łdots, I. S.-J. I., & undefined 2024. (2024). Sustainability Learning: Project Based Learning Integrated Chemo-Entrepreneurship Approach to Understanding Chemistry and Interest in

Entrepreneurship. *Ejournal.Nusantaraglobal.Ac.Id*. https://doi.org/10.55681/jige.v5i2.2712

Sumarti, S., łdots, M. N.-P. J., & undefined 2018. (2016). Meningkatkan Keterampilan Proses Sains Melalui Pembelajaran Koloid Dengan Lembar Kerja Praktikum Berorientasi Chemo-Entrepreneurship. *Journal.Walisongo.Ac.Id*, *04*(02), 113–117.

Sumarti, S. S., Aris, S. R. S., & Aini, R. N. (2018). Chemoentrepreneurship with Cooperative Integrated Process Inquiry Strategy to Increase Students' Entrepreneurial Interest and Learning Motivation. *Jurnal Pendidikan IPA Indonesia*, *7*(2), 172–180. https://doi.org/10.15294/jpii.v7i2.12206

Van Eck, N. J., & Waltman, L. (2014). Visualizing Bibliometric Networks. In Y. Ding, R. Rousseau, & D. Wolfram (Eds.), *Measuring Scholarly Impact* (pp. 285–320). Springer International Publishing. https://doi.org/10.1007/978-3-319-10377-8_13

Van Eck, N., & Waltman, L. (2010). Software survey: VOSviewer, a computer program for bibliometric mapping. *Scientometrics*, *84*(2), 523–538.

Wijayati, N., & Rengga, W. D. P. (2009). Implementation of Chemo-Entrepreneurship Teaching Approach for Improving Students' Life Skills. *Jurnal Ilmu Pendidikan Universitas Negeri Malang*, *16*(2), 101801.

Xiao, Y., & Watson, M. (2019). Guidance on Conducting a Systematic Literature Review. *Journal of Planning Education and Research*, *39*(1), 93–112. https://doi.org/10.1177/0739456X17723971